Training Courses in Support of GEN-IV Development – The Case of SVBR Technology

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1. SVBR Technology in a nut-shell

2. General HRD issues for SVBR development

3. Pilot International training
SVBR – 100 Basic Features

ADVANCED SAFETY
- Inert to water and air lead-bismuth coolant with a very high boiling temperature (1670 °C)
- Integral nuclear system design without high pressure in primary circuit
- Passive safety systems
- Any radiological emergency possible for SVBR reactor could not lead to radioactive emissions into the atmosphere
- No hydrogen is released during SVBR operation
- Reduced “single-shaft” risk (through larger number of small units)

BROAD APPLICATION
- Electricity supply
- Heat supply
- Desalinated water
- Steam supply to industrial needs

SUSTAINABILITY
- Possibility to work in closed nuclear fuel cycle systems

ECONOMICAL EFFICIENCY
- Factory-made ready-for-installation reactor module transportable by rail ways, vehicles or sea
- Flexibility for local energy needs due to scalable modular design (100-200-300-400-500-600 MWe)
- Possibility of deployment near residential area
- Relative ease of system integration (fewer requirements to local infrastructure)
Multi-Purposes Application of Reactor Unit

**Construction of regional small and medium NPP and NCP** allocated close to the cities and energy-intensive industries, including sites in developing countries that do not have complex power grids for electricity transmission and distribution (developing countries) and in remote areas also.

**Construction of high capacity modular NPP** for large / centralized energy systems, with a gradual build-up of the installed capacity.

**Renovation of retired NPP units**. Renovation activities minimize the unit capital costs two fold as compared with the construction of new capacities.

The concept of coastal desalination nuclear power complex comprising two types of onshore desalination plants (multi-layered distillation and reverse osmosis).

<table>
<thead>
<tr>
<th>Example of possible allocation</th>
<th>Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction of terminals, port “Taman” (Krasnodarsky region)</td>
<td>Transportation</td>
</tr>
<tr>
<td>Oil and gas and chemical complex (Primorsky kray.)</td>
<td>Oil &amp; Gas</td>
</tr>
<tr>
<td>Zheleznorudniy Ore Mining and Processing Industrial Complex (Buryatiya)</td>
<td>Metal industry</td>
</tr>
<tr>
<td>“Peschanka” gold-copper field development (Chukotsky region)</td>
<td>Mining</td>
</tr>
</tbody>
</table>

1.SVBR technology
Construction of Pilot NPP with SVBR-100

Prototype nuclear plant is to be constructed in Dimitrovgrad, Ulyanovsk region near the Russian State Atomic Reactor Research Institute.

EVENTS BEHIND:
- Public hearing
- Authorized site (signed rental agreement)
- Signed collaboration agreement between Dimitrovgrad government

NPP KEY PARAMETERS:
- Co-generation mode
- Installed electric capacity: 100 MW(e)
- Heat capacity: 100 Gcal/h
- Efficiency factor: ~36%
- Working time: 50 years
- ICUF*: ~90%
HRD Phases for NPP Operating Personnel (General Requirements in RF)

2. HRD Issues

- Independent work admission
- Obtaining a permit
- Duplication
- Examination
- On-the-job training

NPP - site

- Practical training (Analytical simulators, etc.)
- Theoretical training

Training centers
2. HRD Issues

Road Map of SVBR-100 Implementation & HRD Issues

- Training material development: NPP Systems & Equipment
  - General courses
  - Full scope simulator start-up
  - Commissioning personnel

Task Order and Scope of Work development for Analytical Simulator (AS)

Development of AS
- AS start-up
- Training with the use of AS

Workforce analysis & Staffing Plan development
- Training start-up
  - Plant Shift Supervisor (14)
  - Unit Shift Supervisor (14)
- Reactor hall shift supervisor (14)
- Turbine hall shift supervisor (14)
- Senior reactor operator (14)
- Senior turbine operator (14)

Personnel training schedule & Information System development
- Training modules:
  - SVBR Physics (8 AH)
  - Thermal Hydraulics (8 AH)
  - Coolant Technology (2 AH)
Phases of Training Course Development (based on SAT)

1. Planning based on training needs and tasks analysis
   - Analysis
     - List of competences
     - List of tasks

2. Design
   - Plan of subjects (standard training programme)
     - Goals of training
     - Questions for verification
     - Lesson plans
     - Trainee's textbooks
     - Technical aids, computer training aids, models, posters...

3. Development
   - Training implementation, theoretical, practical, on-the-job training
   - Test of knowledge and skills
   - Internship, duplication, obtaining a permit (if required)

4. Admission

Evaluation of the whole training process in order to improve all SAT phases

- Questionnaires for trainees
- Questionnaires for executives
- Qualification analysis during accident investigations

2. HRD Issues
First International Training Course Focusing SVBR technology (October 2013)

Challenge of Training to Support Implementation of SMRs

According to the IAEA estimates, the world demand for small and medium-sized reactors (100-400 MW) by year 2040 will be about to 500-1000 plants. The aggregate capacity of this market segment is evaluated as – 600 billion US $. SVBR is considered as a promising candidate to meet this international market.

To prepare for this, 07.06.2011 CICE&T hosted Special International Workshop on The Development of Curricula for Training of Foreign Specialists in Russian SMR technology

The Workshop was attended by the representative from IAEA Dr. M. Hadid Subki. Technical Lead, SMR Technology Development. Division of Nuclear Power, Department of Nuclear Energy, the representative from Singapore Energy Studies Institute Mr. Hooman Peimani (Head, Energy Security & Geopolitics).

3. Pilot training
# Training Course Schedule

<table>
<thead>
<tr>
<th>No</th>
<th>Training modules</th>
<th>Ac. Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Potential of SVBR Technology in Sustainable Power Development</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>SVBR Reactor Core Physics</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>SVBR Heat Transfer</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>Coolant Technology</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>SVBR Operation&amp;Contol (Practice with Analytical Simulator)</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>SVBR HRD Issues</td>
<td>8</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>34</td>
</tr>
</tbody>
</table>

3. Pilot training
Training Course Evaluation

Average course rating: 9.00 points

Number of International Participants

<table>
<thead>
<tr>
<th>Country</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Russia</td>
<td>7</td>
</tr>
<tr>
<td>Indonesia</td>
<td>3</td>
</tr>
<tr>
<td>Malaysia</td>
<td>1</td>
</tr>
<tr>
<td>Belgium</td>
<td>1</td>
</tr>
<tr>
<td>Italy</td>
<td>2</td>
</tr>
<tr>
<td>China</td>
<td>2</td>
</tr>
<tr>
<td>Turkey</td>
<td>1</td>
</tr>
<tr>
<td>Czech Rep.</td>
<td>2</td>
</tr>
<tr>
<td>Slovakia</td>
<td>2</td>
</tr>
<tr>
<td>Finland</td>
<td>1</td>
</tr>
<tr>
<td>Singapore</td>
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3. Pilot training
Conclusions

For prototype nuclear power reactor the development of training materials requires high level expertise from the R&D side.

The First International Course focusing the SVBR technology was developed and piloted in ROSATOM Central Institute for Continuing Education & Training to support HRD for Open Joint-Stock Company «AKME-engineering» - owner and operator of SVBR-100.

The Course is available for international participants. Please contact N.Zaitseva@svbr.org VVArtisyuk@rosatom-cipk.ru
Thank you for Your attention!